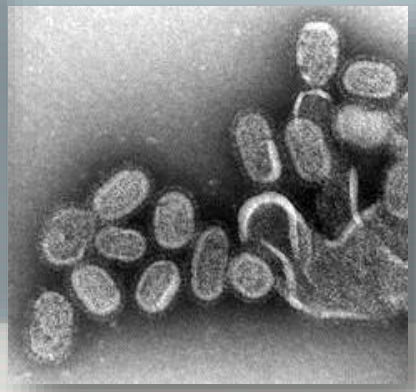
Update on Avian Influenza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Overview

- Introduction: Differences between seasonal flu, pandemic flu and avian flu
- Influenza A viruses
- Avian influenza – Epidemiology and pathobiology (LPAI and HPAI)
- Avian influenza in commercial poultry – Current situation
- Asian lineage H5N1 HPAI
- H7N9 influenza in China
- Prevention and Control

Seasonal Influenza

Influenza virus type A and B

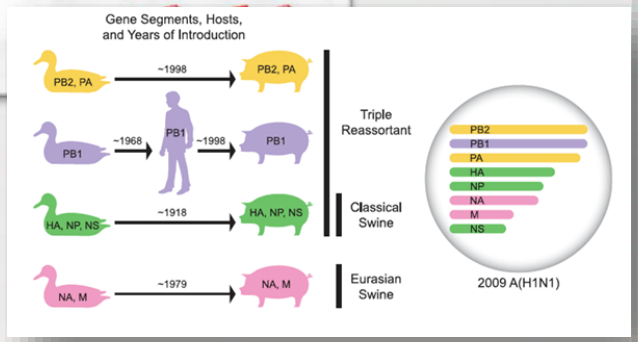
http://www.cdc.gov/flu/index.htm

Pandemic influenza

Emergency hospital, Camp Funston, Kansas 1918

Courtesy of National Museum of Health and Medicine

pH1N1



Nancy Cox, 2009, Science

1918 "Spanish Flu" (H1N1) 20-40 million deaths

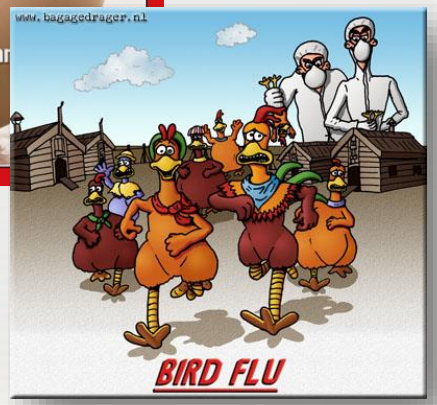
1957 "Asian Flu" (H2N2) 1 million deaths

1968 "Hong Kong Flu" (H3N2) 1 million deaths

Pandemic threats

H5N1 HPAI

668 total cases/393 deaths



H7N9 LPAI

464 total cases/174 deaths

China's deadly new H7N9 bird flu virus may be harder to track than predecessors, scientists say
AP/ *April 3, 2013*

H10N8 LPAI

3 total cases/2 deaths

Influenza in animals

H7N3 HPAI

Mexico Kills 8 Million Chickens to Contain H7N3 Virus
By C. Hsu | Aug 8, 2012 EDT

H5N8 HPAI

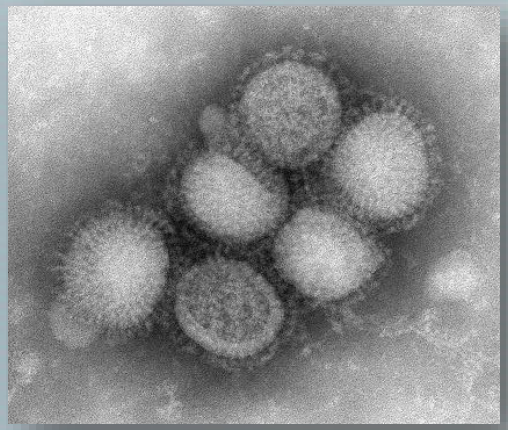
Bird flu worries spread in Europe
By S. Capelouto, CNN. November 24, 2014

H3N2v

Health officials warn fair attendees not to pet pigs due to swine flu fears Published August 31, 2012. FoxNews.com

H5N2 HPAI

Canada bird flu virus identified as 'highly pathogenic' strain.
Published Dec. 5 2014 FoxNews.co



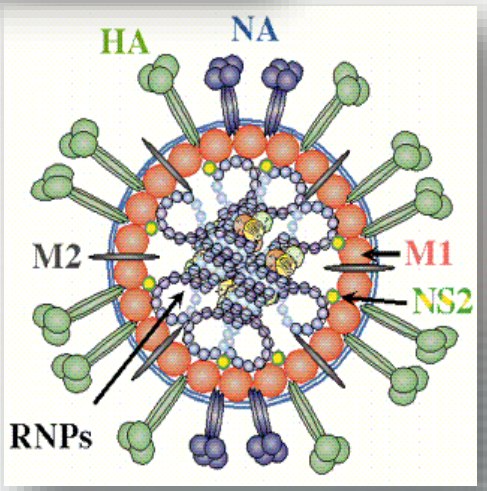
Influenza A viruses

Influenza A viruses

- Influenza A viruses infect humans, birds and other animals including horses, pigs, dogs

- The natural reservoir of influenza A viruses is wild aquatic birds

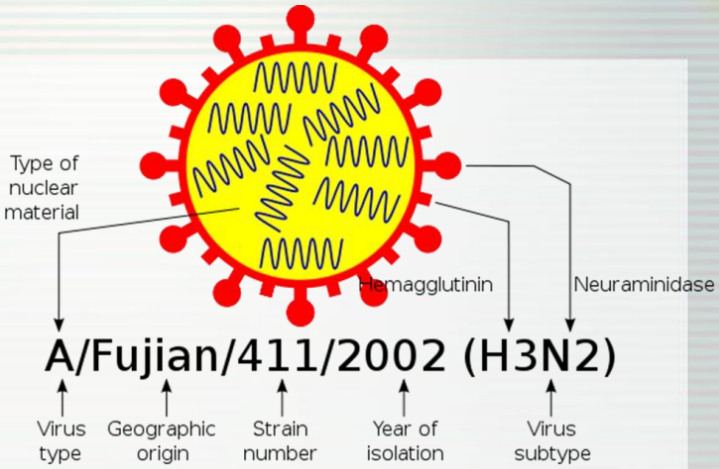
- Classified based on the viral surface proteins hemagglutinin (HA or H) and neuraminidase (NA or N)
-16 H subtypes (or serotypes) and 9 N subtypes

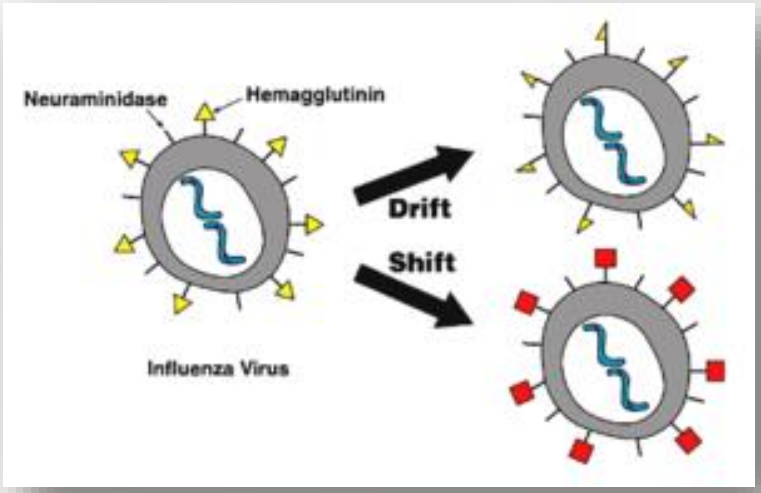


Influenza A viruses

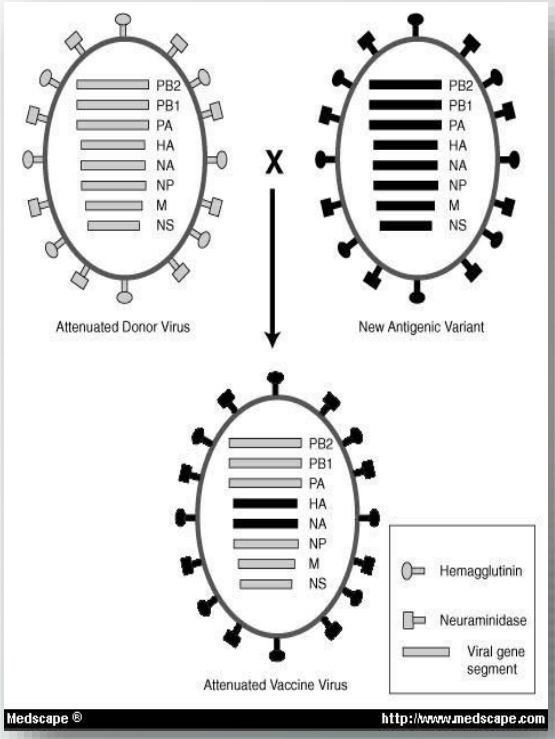
- Orthomyxoviridae family, genus Influenzavirus type A

- Single-stranded (-) sense segmented RNA genome





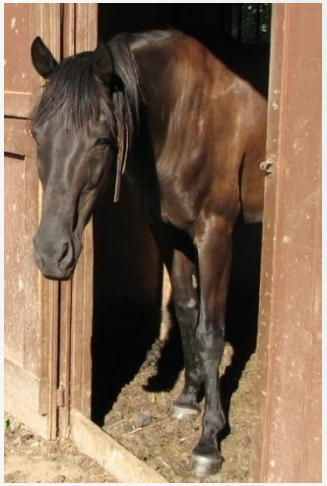
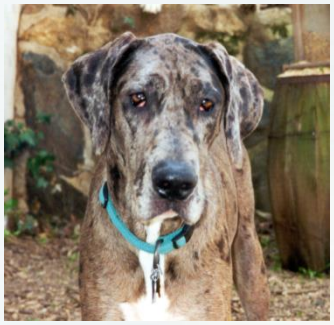
New influenza A viruses are constantly emerging

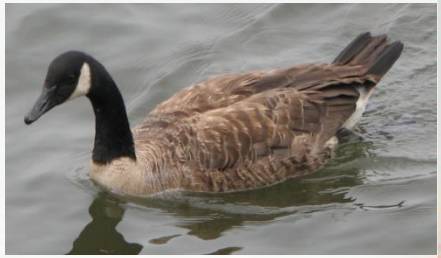


Reassortment

Influenza A viruses
Wide host range, strain dependent

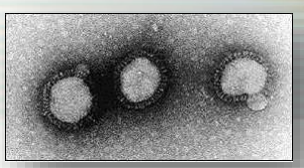




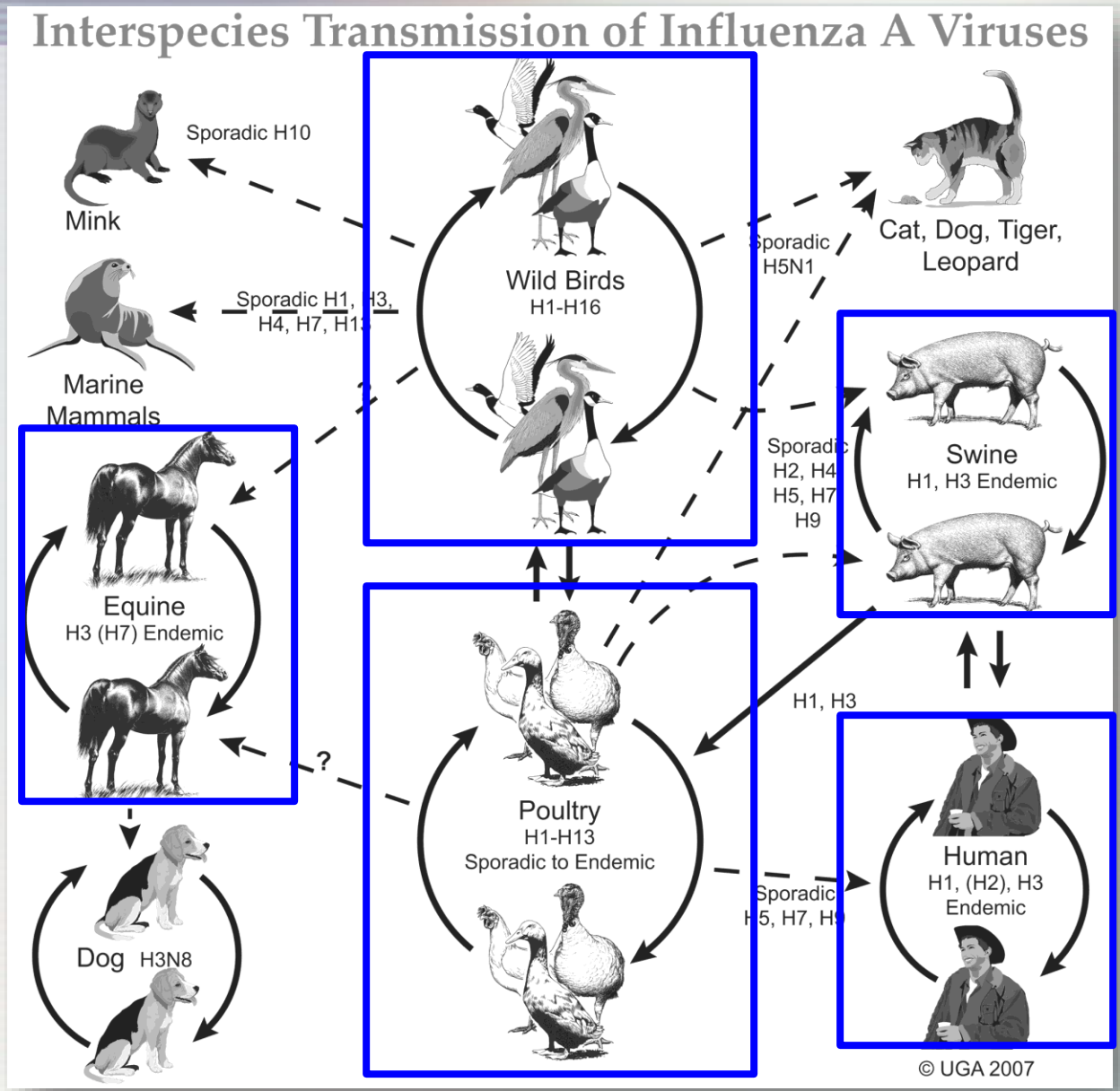

Influenza A viruses



	Mammalia			Aves		
Subtype	Human	Swine	Equine	Wild Ducks	Shorebirds	Poultry
H1	+	++		+	+	++
H2	(+)			+	+	+
H3	+++	++	++	++		+
H4		±		++	+	+
H5	±	±		+	+	++
H6				++	+	+
H7	±		(+)	+	+	++
H8				+		+
H9	±	±		+	++	++
H10				+	+	+
H11				+	+	+
H12				+	+	
H13					++	+
H14				+		
H15				+	+	
H16					+	

H17 – type A influenza from bats

Adapted from Swayne, D.E. Epidemiology of Avian Influenza in Agricultural and Other Man-Made Systems. In: Avian Influenza. Wylie-Blackwell, March, 2008.



Swayne, D.E. Epidemiology of Avian Influenza in Agricultural and Other Man-Made Systems. In: Avian Influenza. Wylie-Blackwell, March, 2008.

Avian Influenza

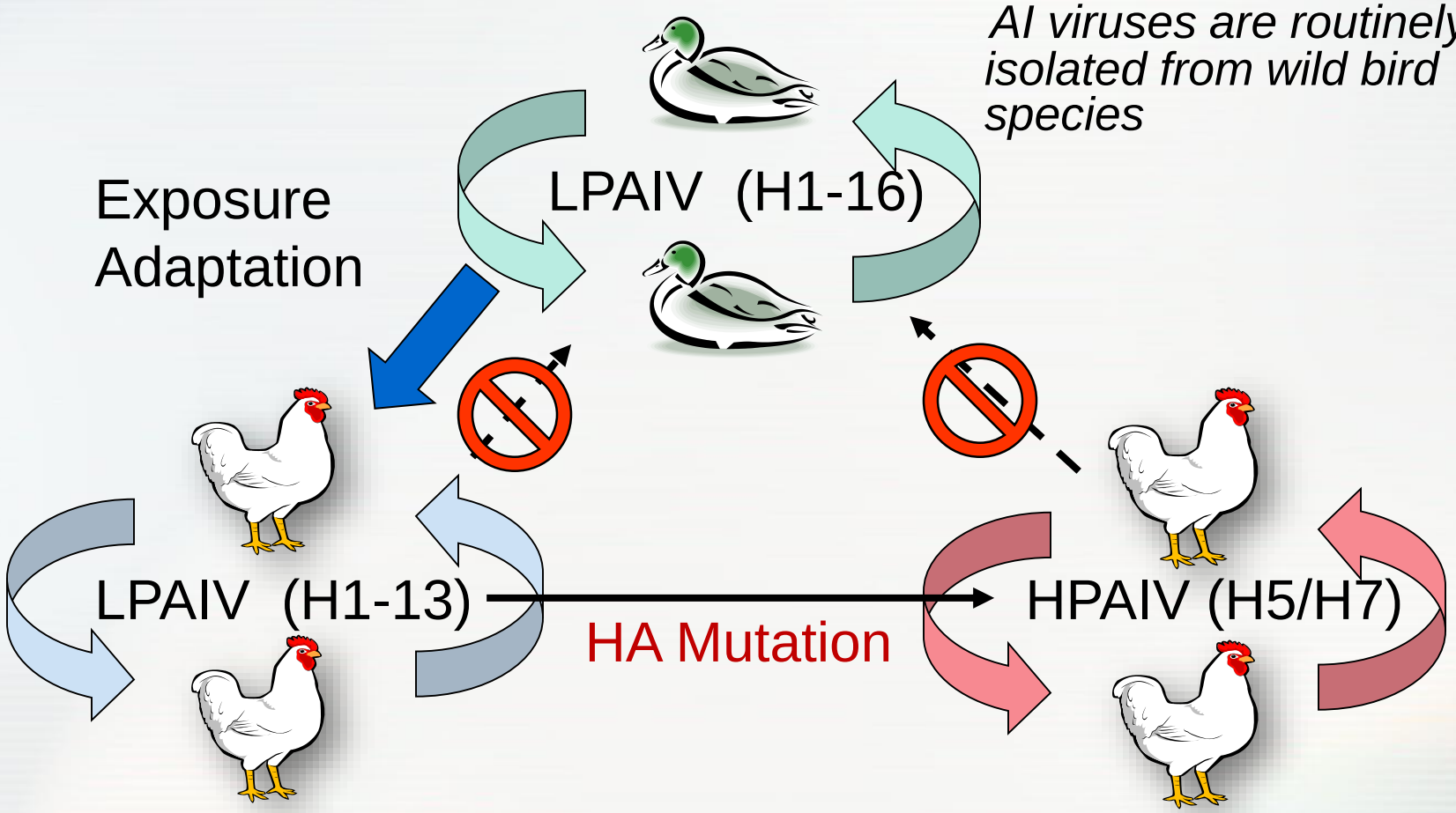
Avian influenza virus: Pathogenicity

- Pathogenicity: Ability to produce lesions, disease and/or death in a host
- Determined by several factors: virus, host, and environmental
- Host differences – *Galliformes vs. Anseriformes*

- Pathotypes:
  - High pathogenicity (HPAI): some H5 and H7 viruses
  - Low pathogenicity (LPAI): most H1-13 virus

LPAI H5 or H7 subtypes can mutate into HPAI viruses

AIV: Ecology and Epidemiology



The vast majority of HPAI viruses never re-enter the wild bird system

What do we mean by highly pathogenic?

Only applies to gallinaceous poultry (chickens, turkeys, quail)

- Regulatory definitions from OIE
  1. Highly pathogenic avian influenza (HPAI) virus lethal for 75% or more of intravenously inoculated susceptible chickens (IVPI > 1.2) within 10 days.
  2. H5 or H7 subtype that has an amino acid sequence at the hemagglutinin cleavage site 'compatible' with HPAI due to multiple basic amino acids

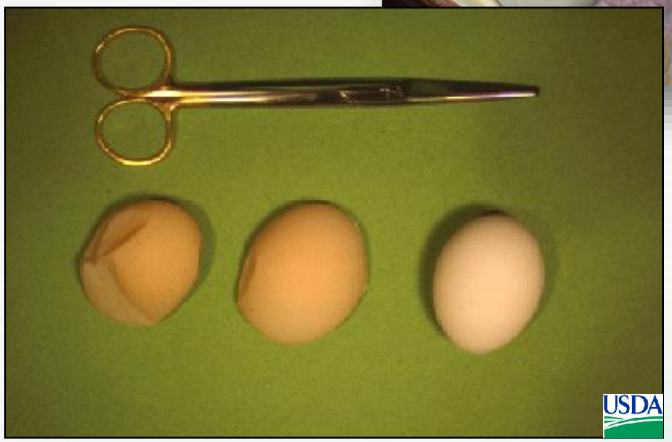
- Notifiable avian influenza
  - H5/H7 HPAI
  - H5/H7 low pathogenicity notifiable AI (LPNAI)
- Other low pathogenicity avian influenza viruses are not notifiable (H1-4, H6, H8-16)

Low Pathogenicity Avian Influenza

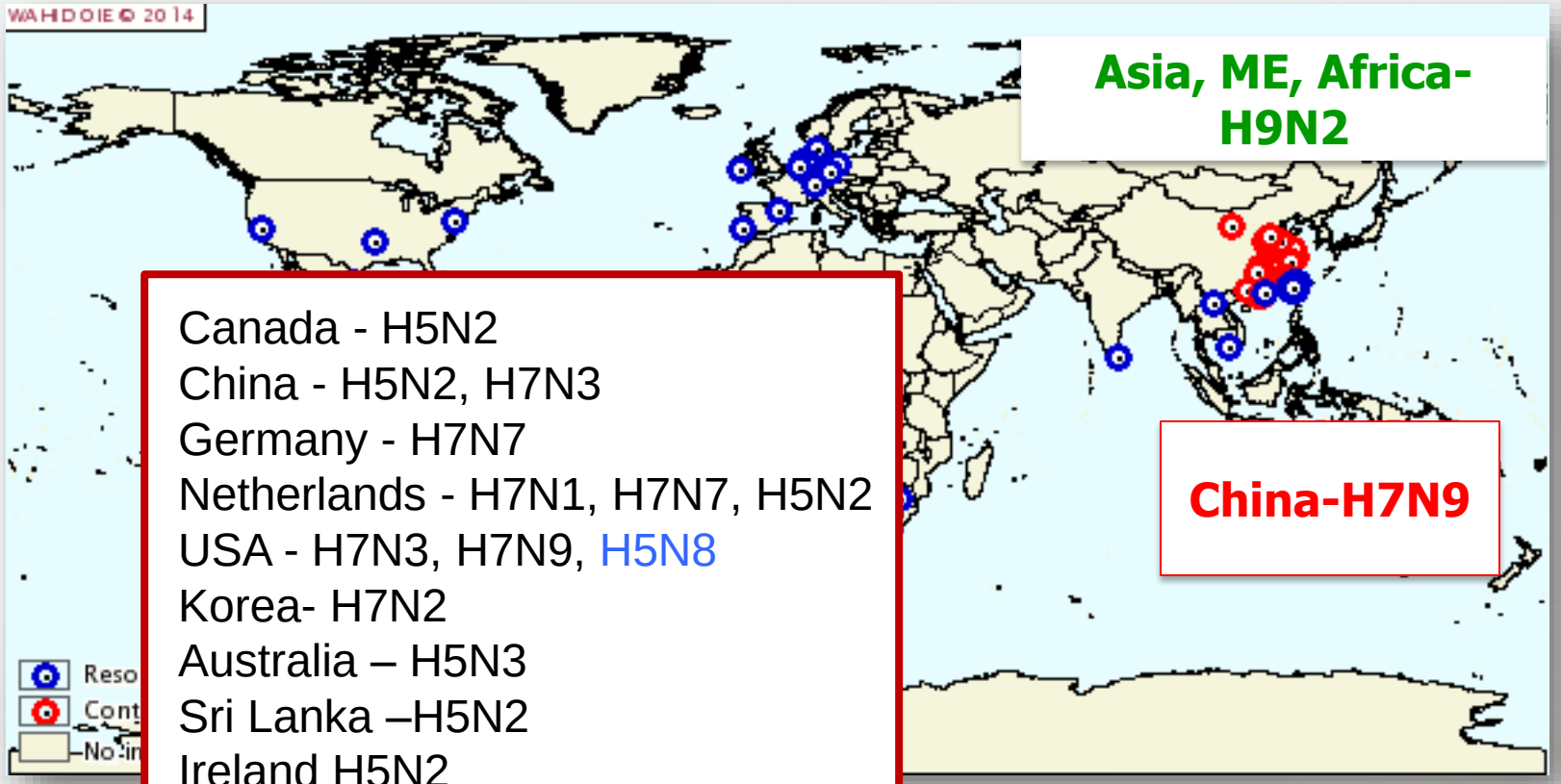
Chickens and turkeys

Infections - variable clinically

- Respiratory signs
- Rhinitis and tracheitis
- Decrease in feed and water consumption
- Ocular discharge
- Diarrhea
- Drops in egg production
- Mild increase in mortality



LPAI outbreaks reported to the OIE *2012-2014*

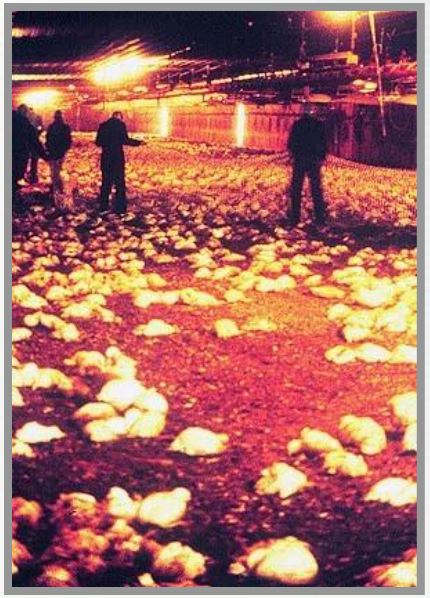


http://web.oie.int/wahis/public.

H5 and H7 avian influenza in its low pathogenic form in poultry is a notifiable disease as per Chapter 10.4. on avian influenza of the Terrestrial Animal Health Code (2010)

Highly Pathogenic Avian Influenza

Chickens and turkeys



Severe systemic disease. Highly contagious

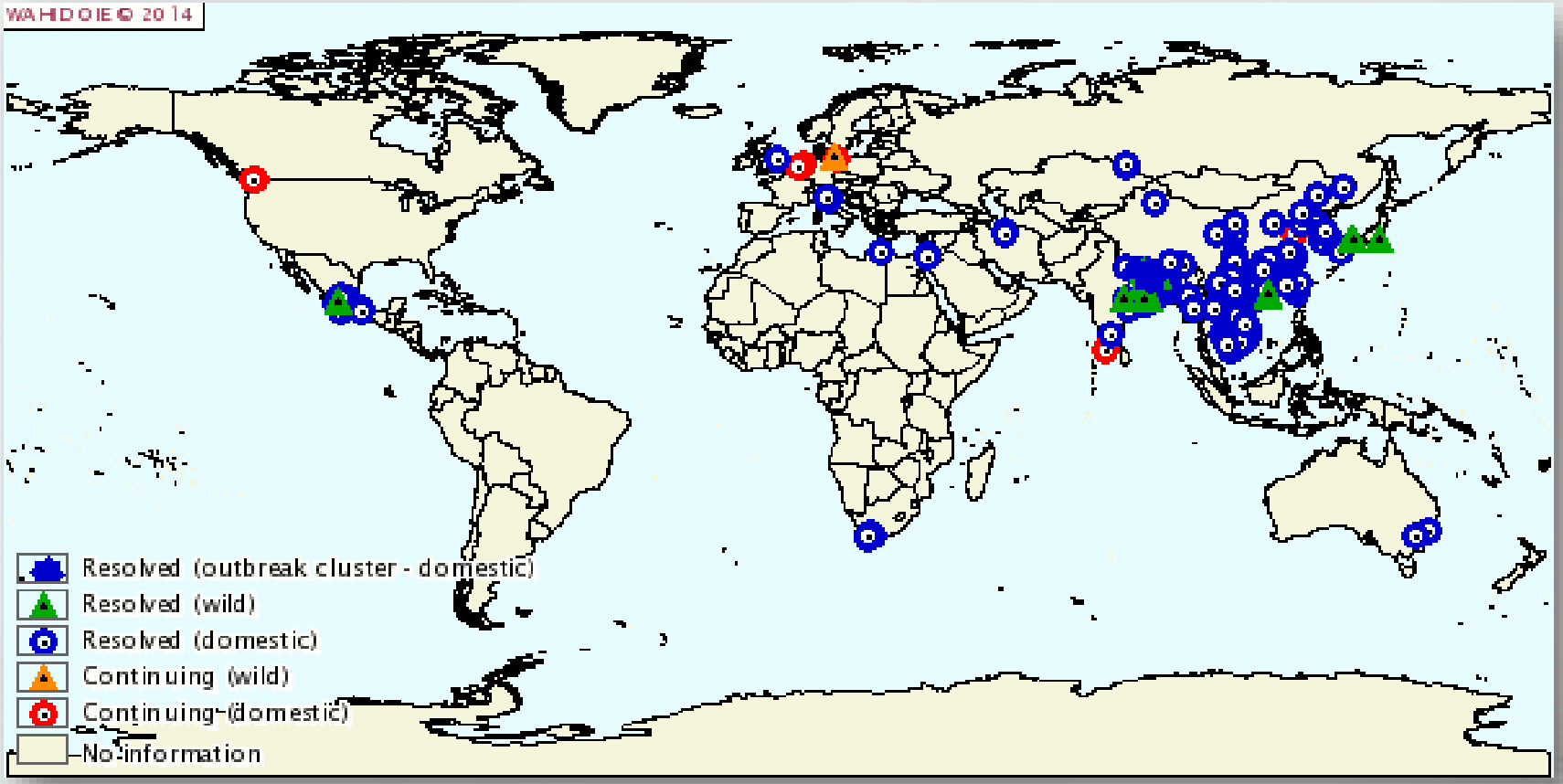
- High mortality. Rapid spread
- Severe decrease in feed and water consumption
- +/- nervous signs
- Edema of head and legs
- Pulmonary edema, congestion and hemorrhage
- Visceral hemorrhage

37 HPAI Disease Events

1890's-1950's numerous outbreaks, subtypes not known
1924-25, North east US H7N7?
1. 1959-Scotland, H5N1
2. 1961-S. Africa, H5N3
3. 1963-England, H7N3
4. 1966-Canadaa, H5N9
5.1975-Australia, H7N7
6. 1979 –Germany, H7N7
7. 1979-England, H7N7
*8. 1983-84 - USA, H5N2
9. 1983-Ireland, H5N8
10. 1985-Australia, H7N7
11. 1991-England, H5N1
12. 1992-Australia, H7N3
13. 1994-Australia, H7N3
*14. 1994-95-Mexico, H5N2
15. 1995 and 2004 –Pakistan, H7N3
16. 1997-Australia, H7N4
17. 1997-Italy, H5N2
**18. 1996-present – Asia/Europe/ Africa, H5N1
*19. 1999-2000 - Italy, H7N1
*20. 2002 - Chile, H7N3
*21. 2003 – Netherlands, H7N7
*22. 2004 – USA, H5N2
*23. 2004 – Canada, H7N3
24. 2004, 2006 – S. Africa, H5N2
25. 2005? – N. Korea, H7N7
*26. 2007 – Canada, H7N3
27. 2008 – England, H7N7
28. 2009- Spain, H7N7
29. 2011- South, Africa H5N2
30. 2012- Taipei, H5N2
31. 2012- South Africa, H7N1
32. 2012. Mexico, H7N3
33. 2012: Australia, H7N7
34. 2013: Italy, H7N7
35. 2013: Australia, H7N2
36. 2014: S. Korea and Europe, H5N8
37. 2014: Canada, H5N2

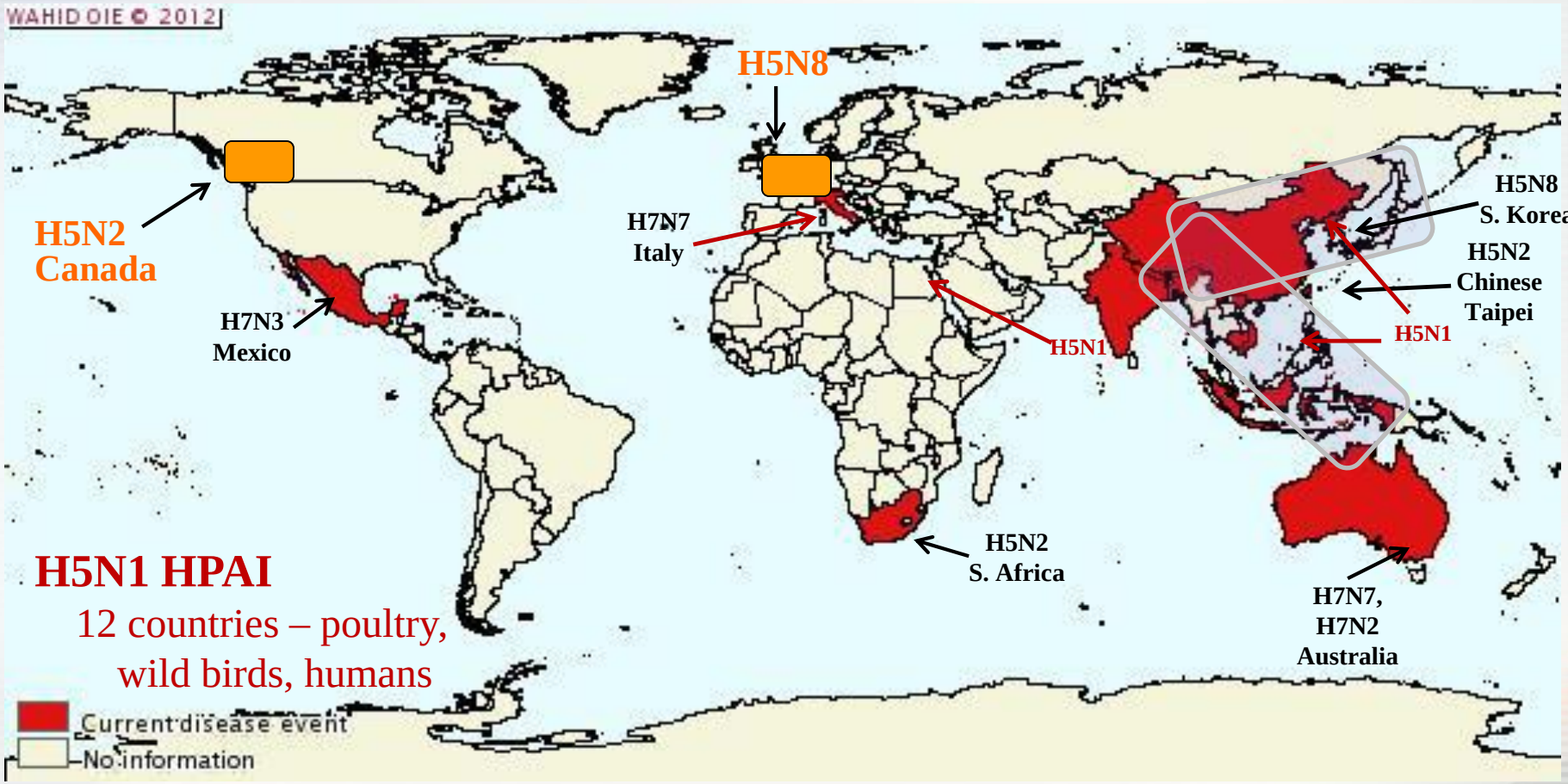
*LPAIV ⇒HPAIV
**Largest epizootic on record

HPAI outbreaks reported to the OIE *2012-2014*



H5 and H7 avian influenza in its low pathogenic form in poultry is a notifiable disease as per Chapter 10.4. on avian influenza of the Terrestrial Animal Health Code (2010)

HPAI (7/1/2012-2/7/2014): 18 countries



H5N2 HPAI

S. Africa – ostriches

Chinese Taipei – native chicken

H5N8 HPAI

S. Korea – ducks and other poultry

H7N2 HPAI

Australia - layers

H7N3 HPAI

Mexico - layers

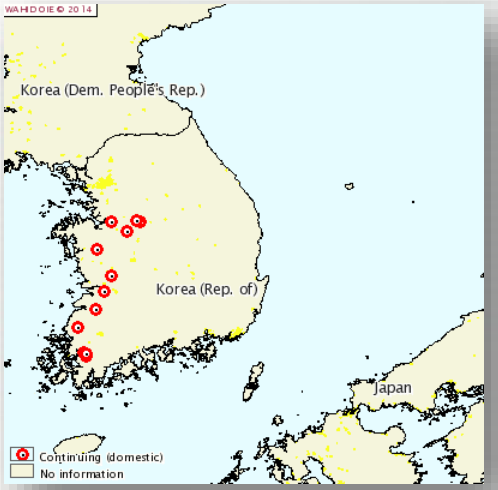
H7N7 HPAI

Italy – poultry

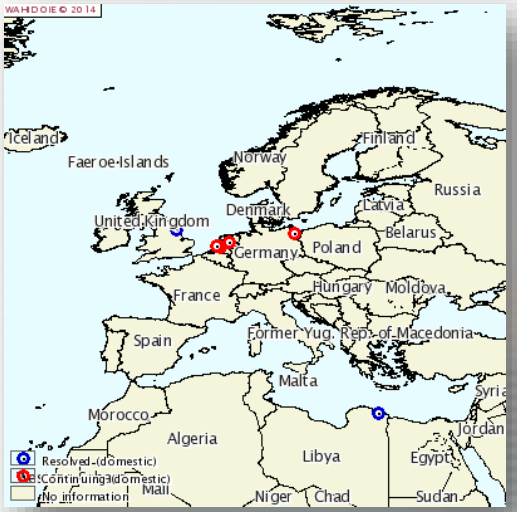
Australia - layers

H5N8 HPAI 2014

- Early this year, China, Japan and South Korea reported outbreaks of H5N8 in poultry farms as well as findings in migratory birds
- South Korea: 26+ outbreaks: breeding ducks, meat ducks, layer chickens, broilers, breeders. 15,114 deaths and 494,346 culled



- Since early November 2014, H5N8 HPAI was reported at poultry farms in Germany (1 farm), Netherlands (3 farms), and the UK (1 farm)
- A sample collected from an wild Common Teal legally hunted in Germany tested positive for HPAI H5N8



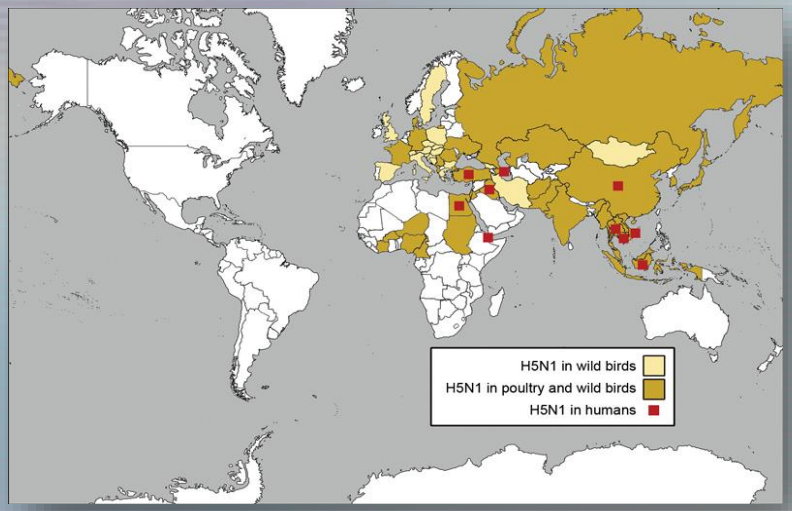
H7N3 HPAI in Mexico

- Reported to OIE 6/21/2012 – Jalisco
  - 44 farms
  - 10.6 million chickens affected– all layers
  - 11 million culled in outbreak zone
- Temporary vaccination authorized: 165.9 m doses used by Jan/2013
- Limiting factors in control:
  - Large number of diagnostic testing: 730 premises in Jalisco
  - Labor intensive depopulation of individual layers
- Resurgence in 2013 (central Mexico):
  12/1/2013 to 31/8/2013 – 64 outbreaks in Jalisco, Aguascalientes, Guanajuato and Puebla
  - 550,322 deaths, 6,230,022 culled
  - Layers, broiler breeders, backyard poultry and broilers
- H7N3 total – 110 outbreaks, 20 million poultry

H5N2 HPAI in Canada

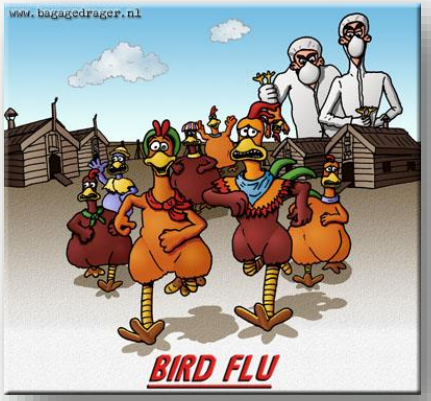
- Canadian health officials confirmed H5N2 HPAI in two of the four H5-related poultry outbreaks in British Columbia's Fraser Valley near Vancouver

Up to 140,000 chickens and turkeys culled in B.C. as officials try to contain outbreak of highly-contagious avian flu
T. Hopper | December 7, 2014. The National Post



Asian lineage H5N1 HPAI

H5N1 HPAI –The bird Flu



H5N1 HPAI

- H5N1 HPAI viruses continue to circulate in poultry and cause disease, and remain a threat to human and animal health (OIE-FAO-WHO)
- Outbreaks in poultry have seriously impacted livelihoods, the economy and international trade in affected countries

Ecology and Epidemiology - H5N1 HPAI

LPAIV (H1-16)

Exposure
Adaptation

Asian H5N1 HPAIV
Re-adaptation

LPAI

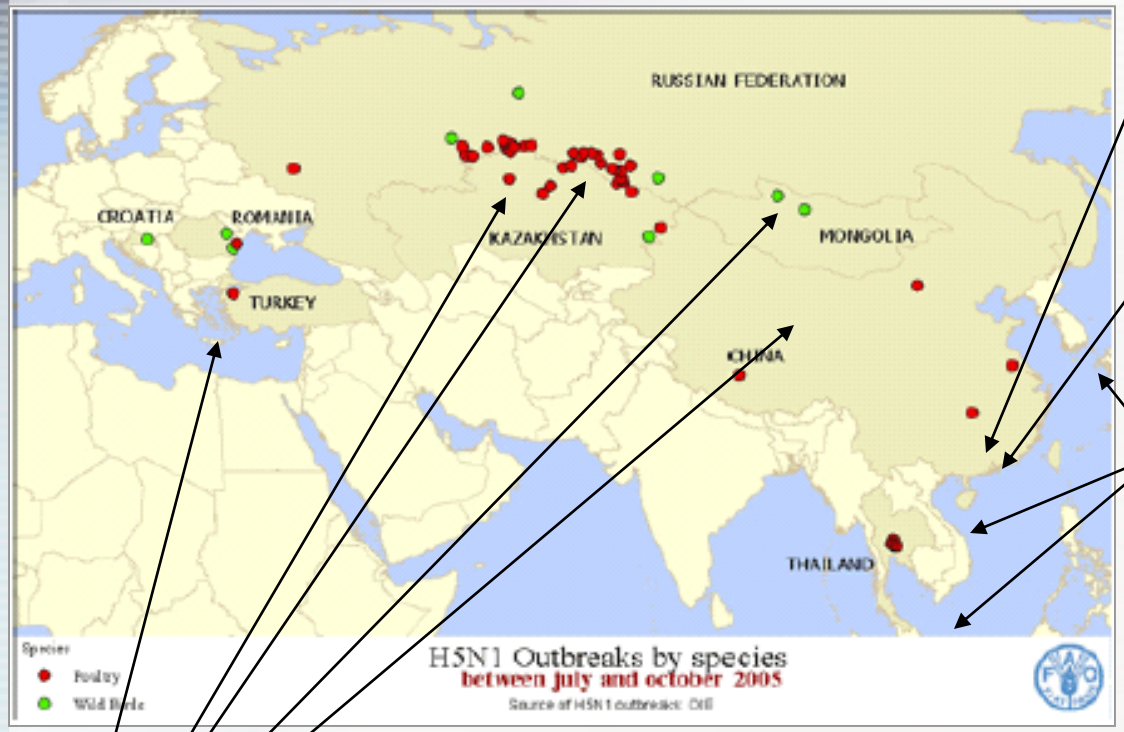
HA Mutation

HPAIV

Mammals

D. E. Swayne, 2007

H5N1 HPAI Epizootics



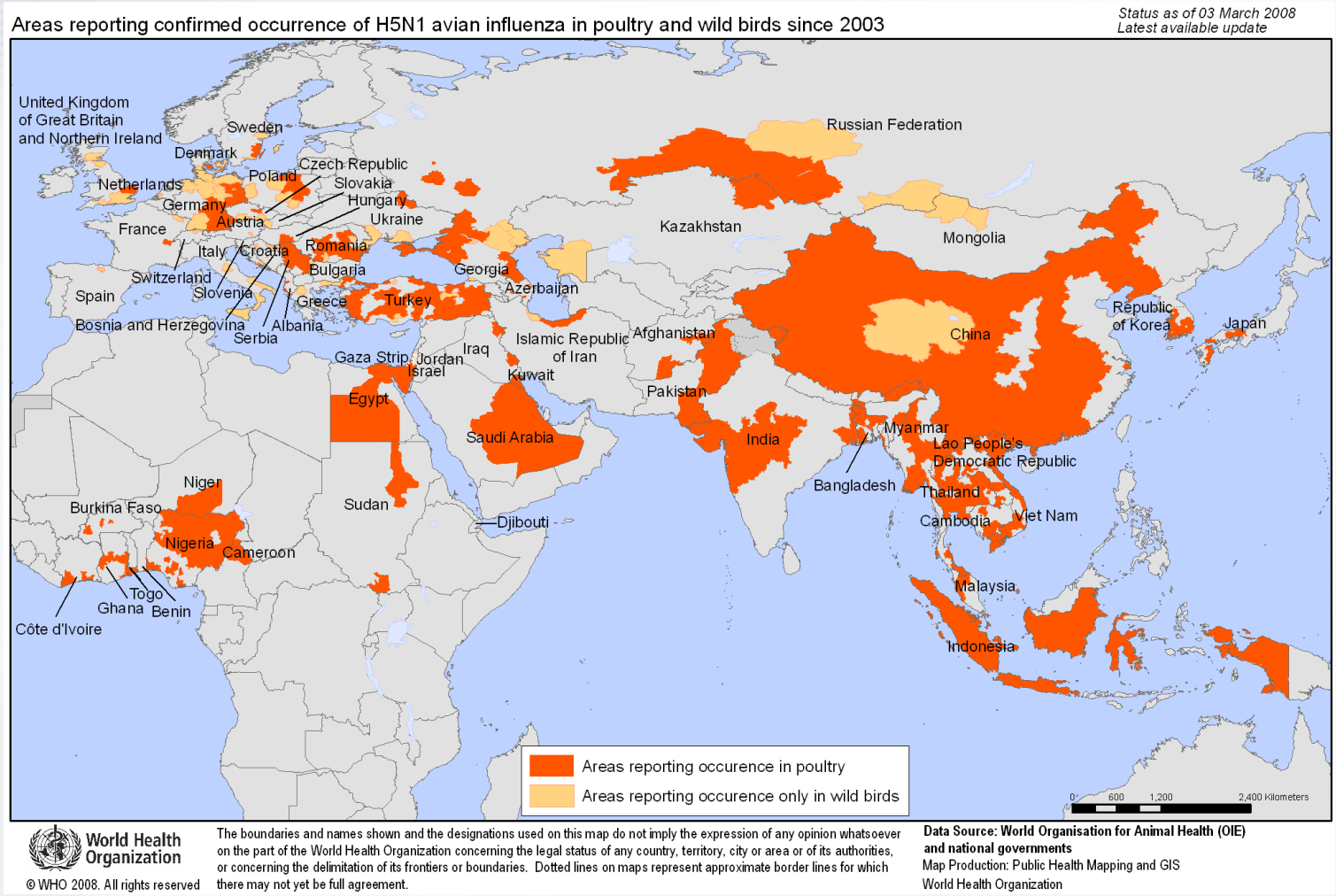
1. **Beginning - China: 1996-2006**
2. **Local extension - Hong Kong: 1997, 2001-3**
3. **SE Asian Regional Extension**
   - **S. Korea: 2003-4**
   - **Vietnam: 2004-6**
   - **Japan: 2004**
   - **Thailand: 2004-6**
   - **Cambodia: 2004-6**
   - **Laos: 2004-6**
   - **Taiwan (smuggled ducks): 2003**
   - **Indonesia: 2003-6**
   - **Malaysia: 2004**

4. Central Asia & E. Europe, wild bird –

- **Mid-2005: China (Qinghai Lake), Russia, Mongolia, Kazakhstan**
- **Late-2005: Turkey, Romania, Kuwait, Croatia, Ukraine, Cyprus**

D. E. Swayne, 2007

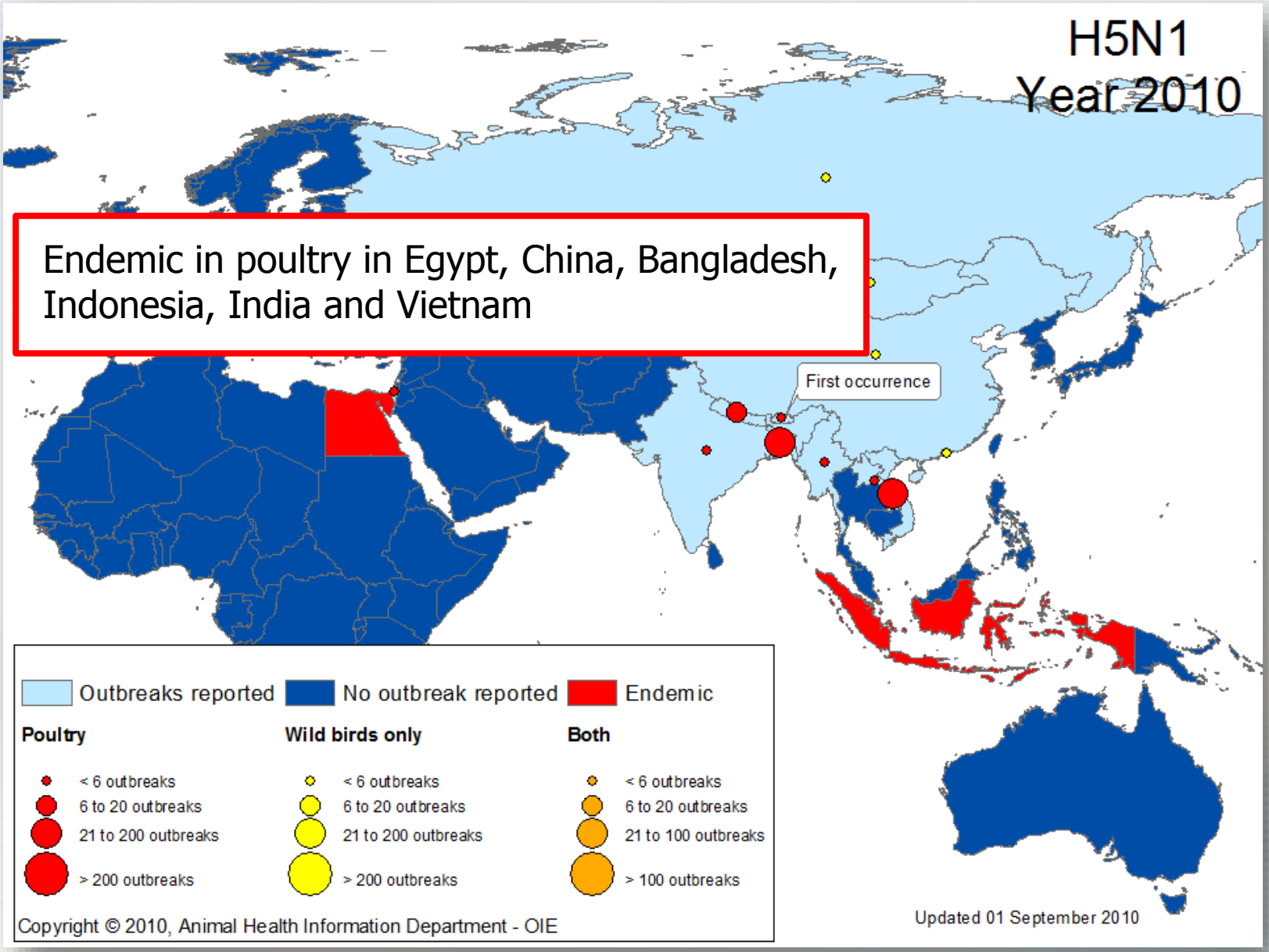
H5N1 HPAI: 2006-2008



Africa
India
Bangladesh
Malaysia
Russia
Myanmar
Israel
Laos
Poland
etc.

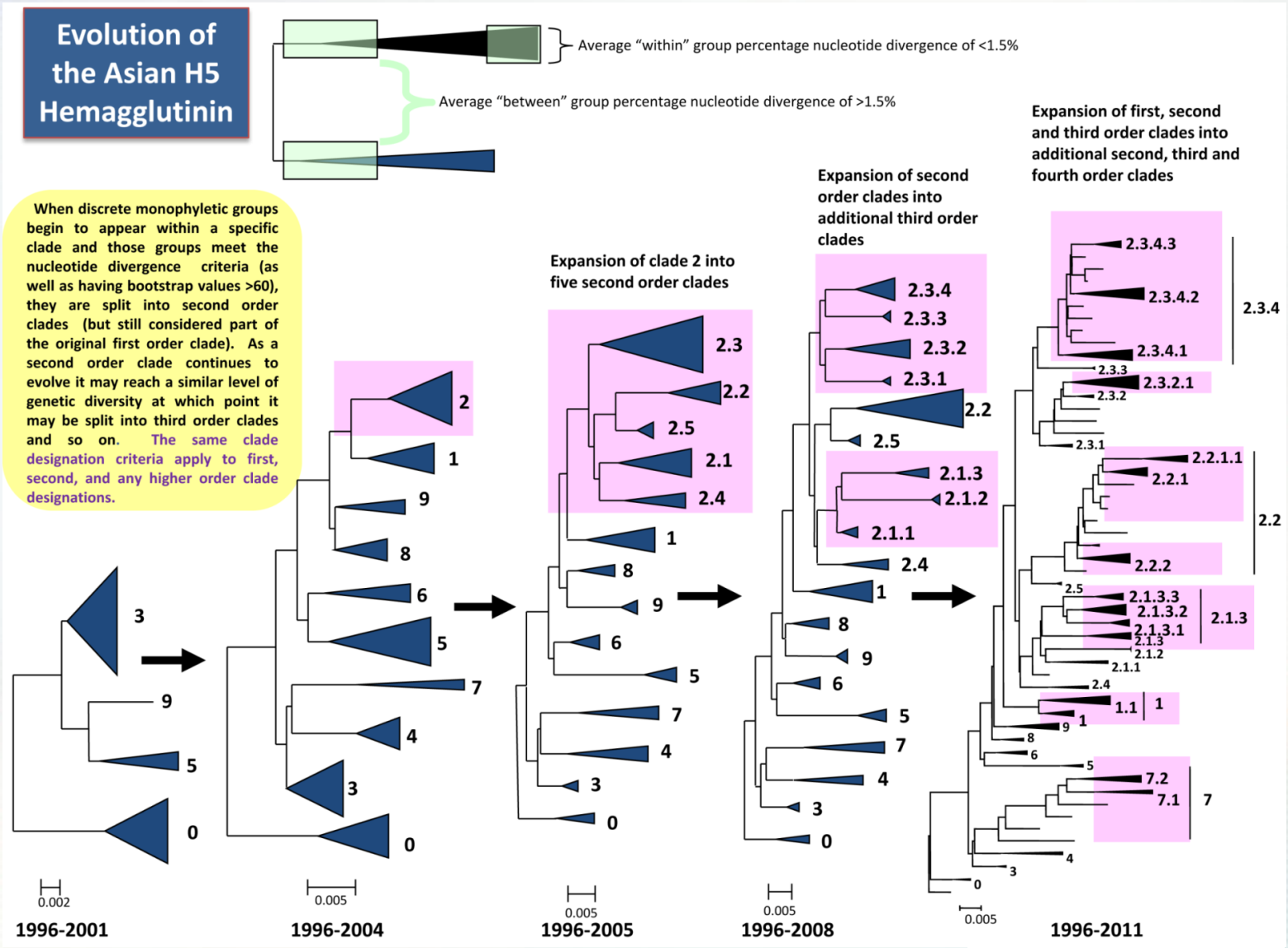
- **+55 countries with cases in wild birds and/or poultry**
- **Over 220 million birds dead or culled 2004-2008 (FAO)**

H5N1 HPAI


H5N1
Year 2010
Endemic in poultry in Egypt, China, Bangladesh, Indonesia, India and Vietnam
First occurrence
Outbreaks reported
No outbreak reported
Endemic
Poultry
< 6 outbreaks
6 to 20 outbreaks
21 to 200 outbreaks
> 200 outbreaks
Wild birds only
< 6 outbreaks
6 to 20 outbreaks
21 to 200 outbreaks
> 200 outbreaks
Both
< 6 outbreaks
6 to 20 outbreaks
21 to 100 outbreaks
> 100 outbreaks
Copyright © 2010, Animal Health Information Department - OIE
Updated 01 September 2010

H5N1 HPAI in Vietnam

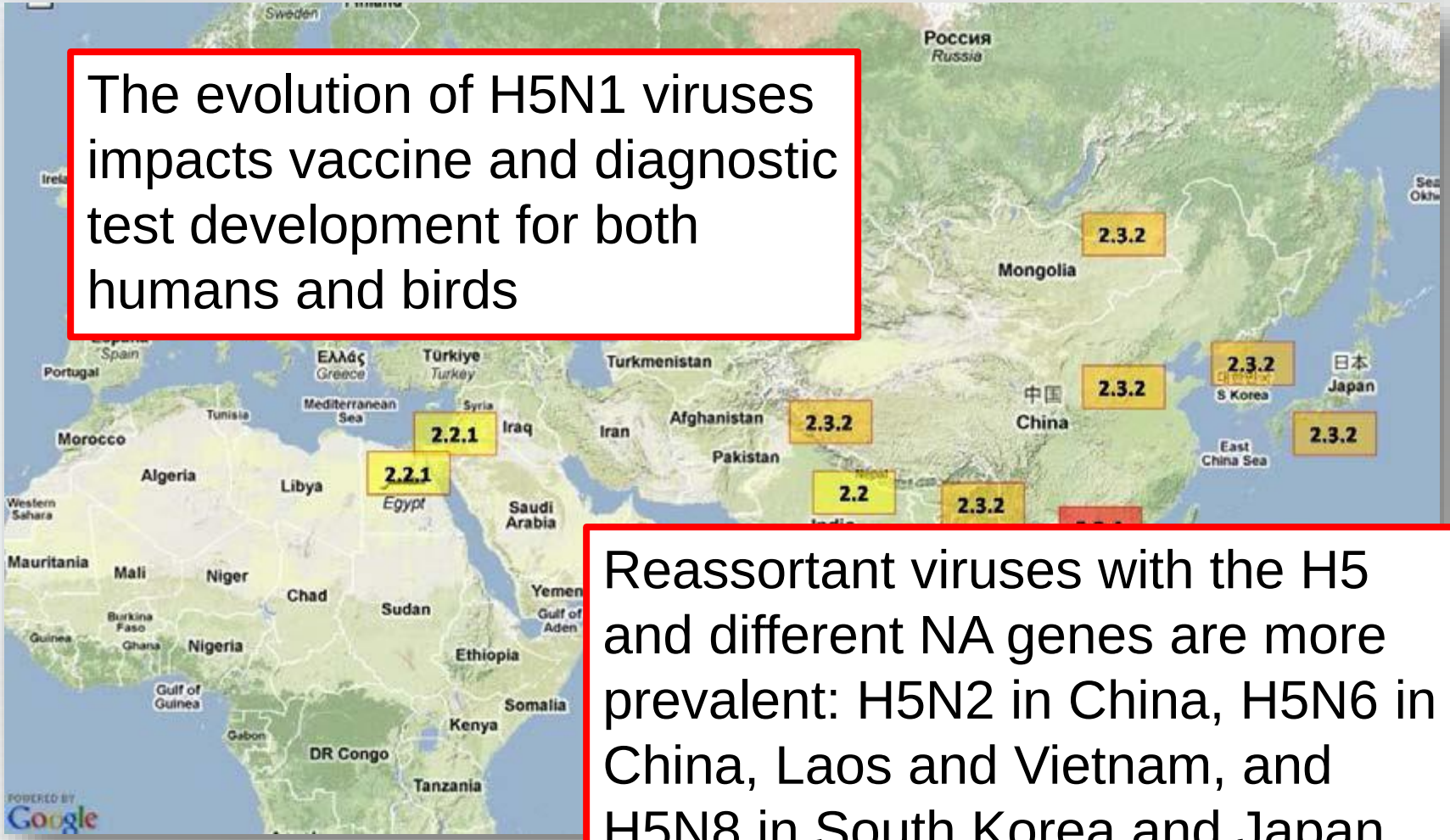
H5N1 HPAI viruses continue evolving



www.WHO.int

H5N1 HPAI viruses continue evolving

The evolution of H5N1 viruses impacts vaccine and diagnostic test development for both humans and birds



Reassortant viruses with the H5 and different NA genes are more prevalent: H5N2 in China, H5N6 in China, Laos and Vietnam, and H5N8 in South Korea and Japan

H5N1 HPAI and Public Health

Country	Total 2003-2014	
	cases	deaths
Azerbaijan	8	5
Bangladesh	7	1
Cambodia	56	37
China	47	30
Djibouti	1	0
Egypt	177	63
Indonesia	197	165
Iraq	3	2
Lao	2	2
Myanmar	1	0
Nigeria	1	1
Pakistan	3	1
Thailand	25	17
Turkey	12	4
Viet Nam	127	64
Total	**668**	**393**

Cumulative Number of Confirmed Human Cases of H5N1. Reported to WHO. 2003-2014

H5N1 HPAI and Public Health

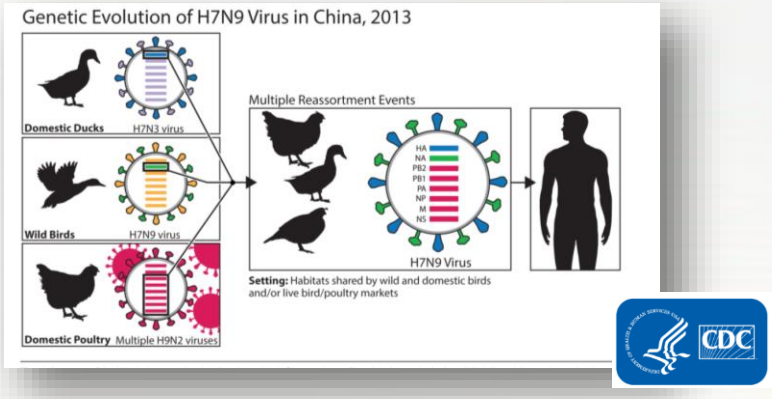
- Human cases of H5N1 infection are rare and sporadic events, occurring mostly in areas where the virus is circulating endemically in poultry
- Exposure risks for human infection
  - Exposure one week before illness to poultry, especially direct handling of sick or dead poultry
  - Women- preparers of food
  - Limited human-to-human transmission
- H5N1 HPAI has not been a Food Safety issue
  - Virus is killed by pasteurization and cooking

Natural Human AI Virus Infections

Year	Country	Subtype	Cases	Deaths
1959	USA	H7N7 HPAI	1	0
1978-9	USA	H7N7 LPAI	?	0
1996	U. Kingdom	H7N7 LPAI	1	0
1999-2011	China-Hong Kong	H9N2 LPAI	7+	0
2002-3	USA	H7N2 LPAI	2	0
2003	Netherlands	H7N7 HPAI	89	1
2004	Canada	H7N3 LP/HPAI	2	0
2006	U. Kingdom	H7N3 LPAI	1	0
2007	U. Kingdom	H7N2 LPAI	4	0
2012	Mexico	H7N3 HPAI	2	0
2003-2014	Asia/ME/Africa	H5N1 HPAI	650	389
2013-2014	China	H7N9 LPAI	463	127
2013-2014	China	H10N8 LPAI	3	2

H7N9 influenza in China

- A novel H7N9 influenza A virus emerged in humans eastern China in February of 2013. Cases were often severe and the case fatality rate approximately 32%
- The viral genome was rapidly characterized and was found to be a novel combination of genes from avian influenza viruses



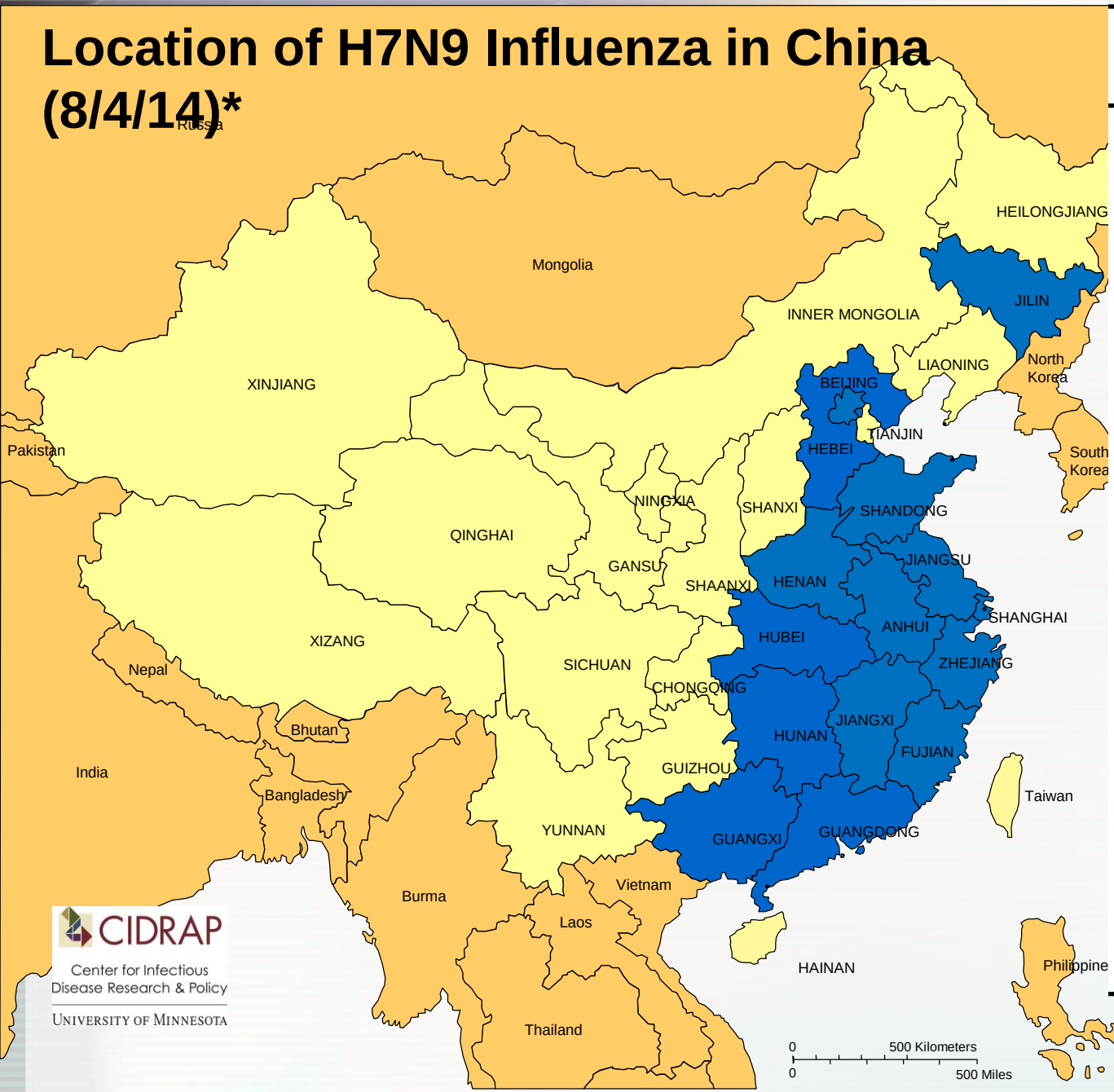
- An avian reservoir was immediately suspected as a likely origin of human infections because of the genes of the virus were of avian origin and because recent contact with poultry was documented with numerous human cases

H7N9 influenza in China

- Chinese veterinary officials quickly started testing poultry associated with live poultry markets (LPM's), commercial poultry operations, and wild birds in the regions where human infections were being reported
- H7N9 viruses were detected in avian species in the LPM's including chickens, pigeons, ducks, and the environment
- Therefore LPM's were suspected of being a major source of human infections, and Chinese officials required closure of LPM's resulting in the reduction of human cases

It's a LPAI

Location of H7N9 Influenza in China (8/4/14)*

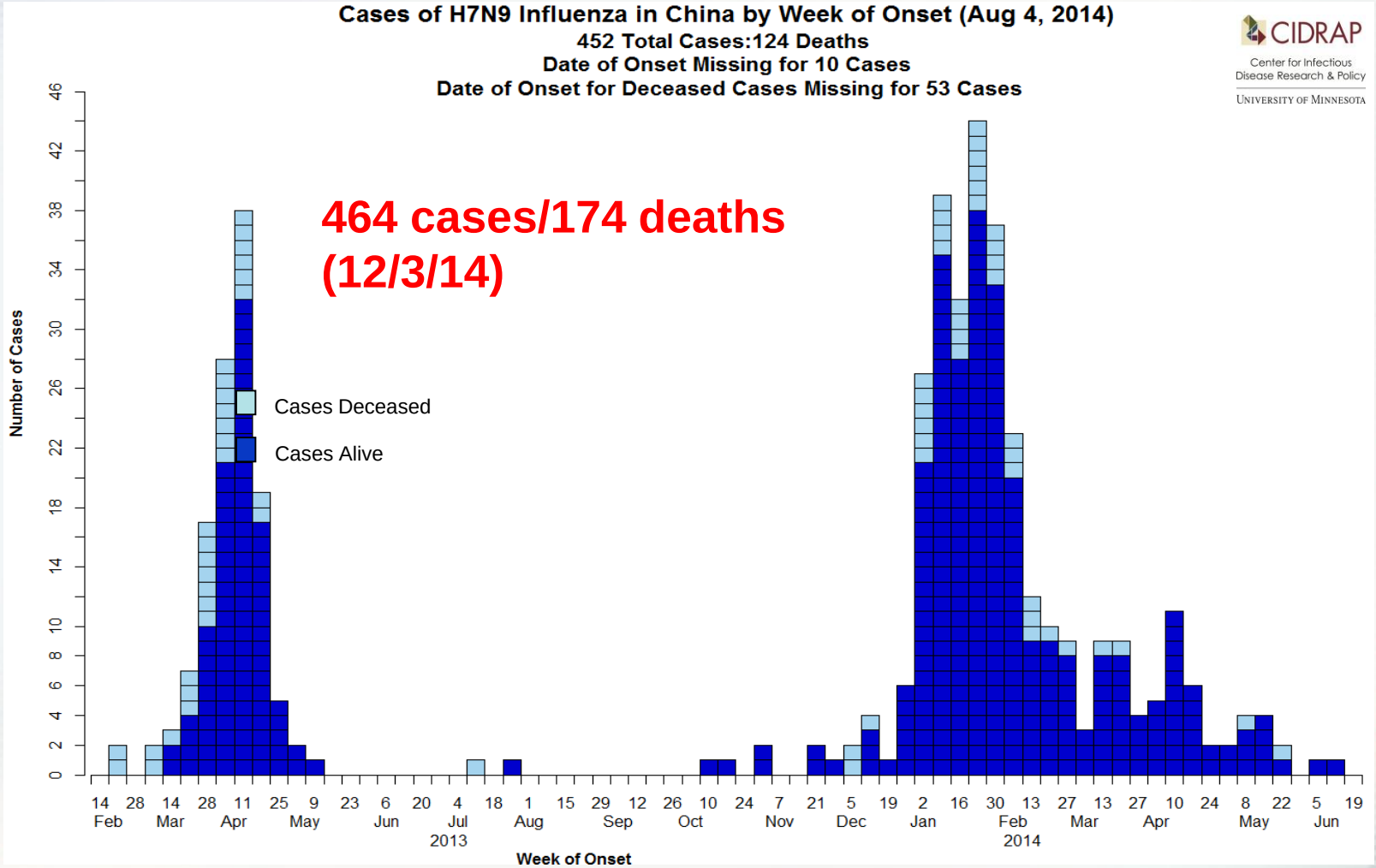


CIDRAP
Center for Infectious Disease Research & Policy
University of Minnesota

Province/ City	Number of Cases
Anhui	18
Beijing	5
Fujian	22
Guangdong	118
Guangxi	3
Hebei	1
Henan	4
Hunan	24
Jiangsu	61
Jiangxi	8
Jilin	2
Shandong	4
Shanghai	42
Zhejiang	140

*452 total cases/124 deaths

H7N9 influenza human cases



Since 2 December **3 new human cases** have been reported in **Guangdong** and **Fujian Provinces** and **Shanghai City**

http://empres-i.fao.org/eipws3g/

Role of LPM's

- Retail LPMs provide a mixing ground for the emergence of novel strains of influenza
  - The closure of 780 LPM's in the Chinese cities of Shanghai, Hangzhou, Huzhou and Nanjing in April 2013 reduced the daily number of H7N9 infections by more than 97 percent *(Cowling et al, The Lancet 2014)*
  - Losses associated with the closures have been estimated at about 57 billion yuan (about $9 billion/ 7 billion euros)
- The findings confirm that LPM closure, though a huge economic setback, is a highly effective intervention to prevent human disease and protect public health

Avian Influenza: Prevention and Control

Avian Influenza

Animal Health Risk and Impact

- Economics: Treatment costs and production impacts
- Animal suffering and welfare
- Negative impact on human nutrition and livelihoods (i.e. Food Security)
- Trade impact: real-risk and pseudo-risk with outcome of trade barriers

Avian Influenza

Economic losses from AI result from:

- Direct losses:
  - Depopulation and disposal
  - High morbidity and mortality
  - Quarantine and surveillance
  - Indemnities
- Indirect losses:
  - loss of consumer confidence in poultry products
  - costs to prevent, manage or eradicate the disease
  - effect on trade
- HPAI negatively impacts the livelihoods of millions of people especially the rural poor
- Early and successful control of AI requires an accurate and rapid diagnosis

http://www.medindia.net/news

Control of Avian Influenza

- In most counties, LPAI and HPAI are not common so prevention is the primary goal
- Surveillance and diagnostics

- When AI occurs, eradication is the overall objective
  - Quarantine, depopulation, cleaning and disinfection

- Appropriate biosecurity
  - Control human traffic
  - Introduction of new birds into flock
  - Avoid open range rearing in waterfowl prevalent areas
- Vaccination can be used as part of a control program during an outbreak
- Wide variation among countries in regards to veterinary diagnostics and animal health infrastructure

In the USA

- HPAI is rare
  - 1924-25: Classic Fowl Plague (H7N7?), New England and upper Midwest states
  - 1929: Classic Fowl Plague (H7N7?), New Jersey
  - 1983-84: H5N2, Pennsylvania, Virginia and Maryland
  - 2004: H5N2, Texas
- H5/H7 LPAI – historically handled by companies and states; since 2005, national control program (prevent H5/7 LPNAIV → HPAIV)
- Other LPAI (H1-4, H6, H8-16) – no federal program but handled by companies and states

Summary

- Avian Influenza viruses are constantly emerging and changing, and will always be a threat to animal and human health
- Both animal and public health sectors at the national, regional and international levels should maintain vigilance in regularly detecting, reporting, and characterizing animal influenza viruses, and in assessing and managing existing and evolving health risks associated with these viruses

Thanks for your attention!